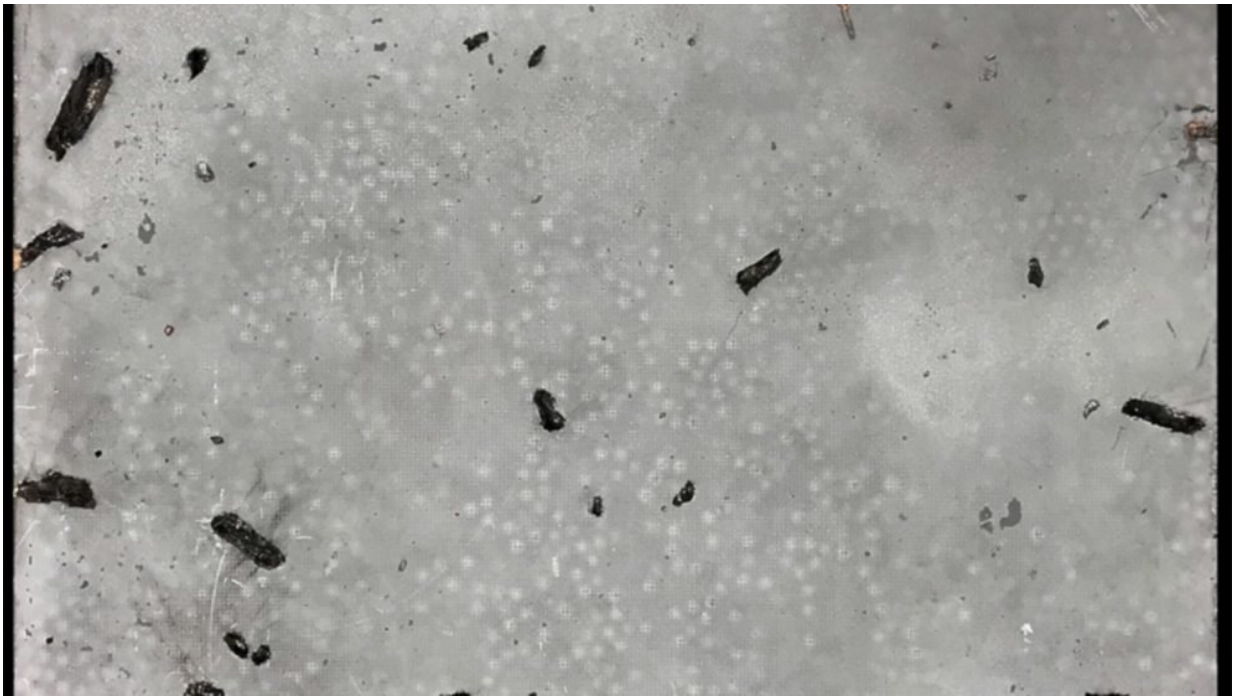


Lightweight metal foam blocks blastwave, debris from high-explosive rounds

March 26 2018, by Matt Shipman



This image shows the CMF panel after the test. The black marks are fragments trapped inside the panel. The image shows there are no cracks or physical bowing -- even after the frags struck at speeds of 5000 feet per second. Credit: North Carolina State University

New research from North Carolina State University and the U.S. Army's Aviation Applied Technology Directorate shows that stainless steel composite metal foam (CMF) can block blast pressure and

fragmentation at 5,000 feet per second from high explosive incendiary (HEI) rounds that detonate only 18 inches away.

"In short, we found that steel-CMF offers much more protection than all other existing armor materials while lowering the weight remarkably," says Afsaneh Rabiei, senior author of a paper on the work and a professor of mechanical and aerospace engineering at NC State. "We can provide as much protection as existing steel armor at a fraction of the weight – or provide much more protection at the same weight.

"Many military vehicles use armor made of rolled homogeneous steel, which weighs three times as much as our steel-CMF," Rabiei says.

"Based on tests like these, we believe we can replace that rolled steel with steel-CMF without sacrificing safety, better blocking not only the fragments but also the [blast](#) waves that are responsible for trauma such as major brain injuries. That would reduce vehicle weight significantly, improving fuel mileage and vehicle performance."

For this study, researchers fired a 23×152 millimeter (mm) HEI round – often used in anti-aircraft weapons – into an aluminum strikeplate that was 2.3 mm thick. 10-inch by 10-inch steel-CMF plates – either 9.5 mm or 16.75 mm thick – were placed 18 inches from the aluminum strikeplate. The researchers assessed that the steel-CMF held up against the wave of blast pressure and against the copper and steel fragments created by the exploding round, as well as aluminum from the strikeplate.

"Both thicknesses of steel-CMF stopped the blastwave, and the 16.75 mm steel-CMF stopped all of the fragments from 15 mm² to over 150 mm² sizes," Rabiei says. "The 9.5 mm steel-CMF stopped most, but not all, of the fragments. Based on the results, a 10 mm steel-CMF plate would have stopped all of the frag sizes."

The researchers also developed computer models of how the steel-CMF plate would perform. When compared to the experimental results, the model matched very closely. The researchers then used the model to predict how aluminum 5083 armor – a type of armor already on the market that has a similar weight and thickness to the 16.75 mm steel-CMF – would perform against HEI rounds.

The model showed that, while aluminum armor of similar [weight](#) to the steel-CMF panels would stop all of the frags, the [aluminum](#) armor would buckle and allow fragments to penetrate much deeper. This would result in more damage to the panel, transferring large amounts of stress to the soldiers or equipment behind the armor. The steel-CMF, on the other hand, absorbs the energy of the blast wave and flying fragments through local deformation of hollow spheres, leaving the steel-CMF [armor](#) under considerably less stress – offering more protection against fragments and blast waves.

Next steps include testing the steel-CMF against improvised explosive devices (IEDs) and high-caliber, mounted ballistics. The researchers have already tested the CMF's performance against hand-held assault weapons, radiation and extreme heat.

The paper, "A study on blast and fragment resistance of composite metal foams through experimental and modeling approaches," is published in the *Journal of Composite Structures*.

More information: Jacob Marx et al. A study on blast and fragment resistance of composite metal foams through experimental and modeling approaches, *Composite Structures* (2018). [DOI: 10.1016/j.compstruct.2018.03.075](#)

Provided by North Carolina State University

Citation: Lightweight metal foam blocks blastwave, debris from high-explosive rounds (2018, March 26) retrieved 10 April 2024 from <https://phys.org/news/2018-03-lightweight-metal-foam-blocks-blastwave.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.